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28 July 1955

CMCC Doc. No. 151,660

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Dear Dick:

We are forwarding herewith five copies of Monthly Progress Report No. 2 covering the work performed on System No. 3 during the period extending from 4 June 1955 to 4 July 1955. Progress on the development of this system appears to be most satisfactory.

Sincerely,

Burt

Burt

Enclosures:

CMCC Doc. No. 163,2006

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AZA Martin

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Monthly Progress Report No. 2

System No. 3

Contract No. A-101

4 June 1955 to 4 July 1955

CMCC Document No. 163,2006

Copy 1 of 7

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1. Introduction

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The detailed design requirements, as well as an outline of the proposed design which meets these requirements, appear in the Technical Exhibit of the System No. 3 Proposal.

b. Prior to the present report period, the basic system design had been completed and work on the detailed design of the system components and some construction had begun. The latter is described in the previous monthly letter report. During the present report period, work has continued on the detailed design and construction of the first breadboard model of the system.

2. System Design

No changes in the basic system design, as previously described, have been made, except for minor changes in the frequency assignment of the r-f heads. This latter was done to avoid interference created in adjacent r-f heads by the local oscillator of a given r-f head.

A packaging design for the receiver unit has been established. The receiver case will be partitioned into shielded compartments with a printed-board receptacle at the bottom of each compartment. Each assembly, consisting of a printed board upon which the components will be mounted, will slide into its compartment and plug into its receptacle. The weight of the completed receiver unit is estimated to be about fifteen pounds.

3. System Components

a. Antenna. Drawings have been completed for a 20:1 scale model antenna which is to be used for pattern measurements, and bids are being received for its construction. A remote-control turntable and Klystron transmitter for the pattern measurement range has been built. It is planned to use the standard method of measurement, using the model antenna as a receiving antenna. The impedance characteristics are to be obtained from a larger model which has yet to be built.

b. R. F. Assembly. Several additions and changes in the design of the r-f heads have occurred. Firstly, a distribution network has been designed and tested whose purpose is to prevent noise figure deterioration due to signal loss caused by connecting a multiplicity of r-f heads to a common antenna. This network consists of an artificial

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line which is employed in a manner similar to that of the wide-band distributed amplifier. The result is a circuit having the required broad-band characteristics, unhindered by the shunt capacitances of the nine r-f heads. In the experimental line a characteristic impedance of 180 ohms was used and the frequency response was essentially uniform up to [] The remaining work on this network consists of adapting it to plug-in construction and checking its operation under actual conditions to see that mismatches are minimized. Secondly, the addition of a common preamplifier stage to precede the nine r-f heads is being contemplated in order to further reduce the noise figure of the receiver system. The G. E. type 6299 planar triode has a low noise figure and a gain-bandwidth product large enough to provide a substantial gain over the 50 mc bandwidth. The purpose of this preamplifier is to raise the level of the input signal sufficiently to permit the signal to override the r-f head noise and the 3 db loss in the matching termination of the artificial line. Thirdly, the local oscillator circuit design has been changed to that of a conventional cathode-coupled oscillator. Attempts to use a modified Butler circuit requiring only a single triode as both oscillator and frequency doubler proved to be unsuccessful due to lack of stability. The latest design has operated satisfactorily.

c. I-F Assembly. Specifications were drafted for the i-f assembly and a contract was let to the R-S Electronics Corporation for its construction. This assembly is to be in subminiaturized form using printed circuitry and is scheduled to be completed on July 22.

d. Second L. O. Assembly.

The second local oscillator is required to generate any one of sixteen crystal-controlled frequencies, lying within the range 6 to 12 mc, which are selected by electronic switching. After investigation of several different oscillator circuits the Pierce oscillator circuit was found to perform best. The crystals are switched on individually by means of diode gates. The use of the Pierce circuit obviates the necessity of switching any associated tuned circuits. In the final design, the sixteen crystals are divided into two groups of eight in conjunction with a 5899 twin triode. The shunting capacity of the crystals reduces the oscillator output so that an untuned r-f amplifier is being used to boost the oscillator output to the level required by the second mixer. A delay of about one millisecond occurs before the oscillations become stable after switching takes place, apparently due to the Q of the crystal; however, this is taken care of by a corresponding delay in the sweep voltage of the Third L. O. Assembly which suspends the searching operation momentarily.

The commutator which controls the crystal gates was originally designed with transistorized counters. Due to the variability of the transistor characteristics, it has been decided to use vacuum tubes for the first model and to defer the use of transistors for this parti-

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cular application until a circuit has been devised which is more tolerant of variations between transistors. Some experimental work remains to be done on the commutator circuit but should be completed within the next few weeks.

e. Third L. O. Assembly. The third local oscillator had been built previously and no additional work has been done on it. The associated sweep and lock-on circuits have been completed during the last period. The lock-on circuit is required to stop and hold the sweep voltage at a fixed level. This is accomplished by maintaining a charge in a capacitor, and some difficulty was encountered initially due to extraneous leakage. At present the hold time, about 20 seconds, appears to be limited by leakage within the gating vacuum tube which is connected to the charging capacitor. This tube leakage is positive, that is, it tends to increase the capacitor charge. It is felt that the hold time can be improved by an order of magnitude by the use of a more appropriate tube and by the addition of negative leakage to balance the positive leakage. Special parts have been ordered for this purpose. Construction of the final breadboard unit has begun. This unit will be used for final evaluation of temperature and voltage stability and will become a part of the final system breadboard.

f. Time Marker Unit. A stable tone generator amenable to compact construction has been tested and will be built around the timing motor which has been ordered from The Haydon Co.

g. Playback Unit. The general function of the playback unit is to transcribe the original tape record and to recover the frequency and time information which appears on the tape in coded form. The block diagram of a tentative design is shown in Figure 1. The original 3-channel tape would be read by two sets of three pickup heads on the Playback Machine. The output from one set of heads would go to three duplicating recorders, one for each channel. The output from the second set of heads would go to the Decoder, where a skimmer would separate out the lock-on pulses which indicate the presence of a message on the tape. These lock-on pulses would then be used to actuate the drive motors of the Duplicating Recorders, so that recording only occurs when a message exists on the original tape. The two sets of heads are displaced so that the audio message would be delayed sufficiently to allow the drive motors of the Duplicating Recorders to attain operating speed. The Decoder also contains computing circuits that translate the frequency and time information on the original tape to a form suitable to actuate the Printer which prints the numerical information on paper. The duplicating recorders are to be equipped with a printer which will place serial numbers on the duplicate tape so that messages can be identified with the printed frequency and time information.

In the above procedure, the playback and recording tape speed would be about three times the original recording speed. A ten-hour original would then require about three hours to process if three Duplicating Recorders are used simultaneously, or ten hours if only one track

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at a time is processed. The end result is then three separate transcribed tapes, having no blank spaces between messages, and a sheet of paper with a list of frequencies and times and identifying message numbers. The interpreter, who must listen to the duplicate would have no long blank periods during which he must wait and also would have no additional computing or data transforming to perform.

A manufacturer of computing equipment has been consulted to explore the possibility of incorporating stock computing components in the playback unit or of having an outside firm build the complete playback unit. Alternate methods of performing the decoding and data handling are being considered and additional manufacturers will be consulted in this regard. Some experimentation has begun on the pulse characteristics of the magnetic tape.

h. Test Unit. This unit, which is to be used in field maintenance of the receiver system, has been undergoing experimental design. The aim of the circuit design is reliability with minimum complexity. An r-f oscillator which requires the switching of the fewest number of components is desired. A Butler circuit, which uses a fifth-overtone crystal in the cathode feedback network has been tried and appears to perform satisfactorily. Parts for the final breadboard unit have been ordered and construction of this unit will then begin.

4. Summary

Experimental work has begun on all parts of the system except for the antenna where construction is still under way. Progress has been made in establishing the acceptability of circuits in the r-f, second L. O., and third L. O. assemblies. It is expected that construction of the various parts of the breadboard model of the receiver unit will be nearly completed during the next period.

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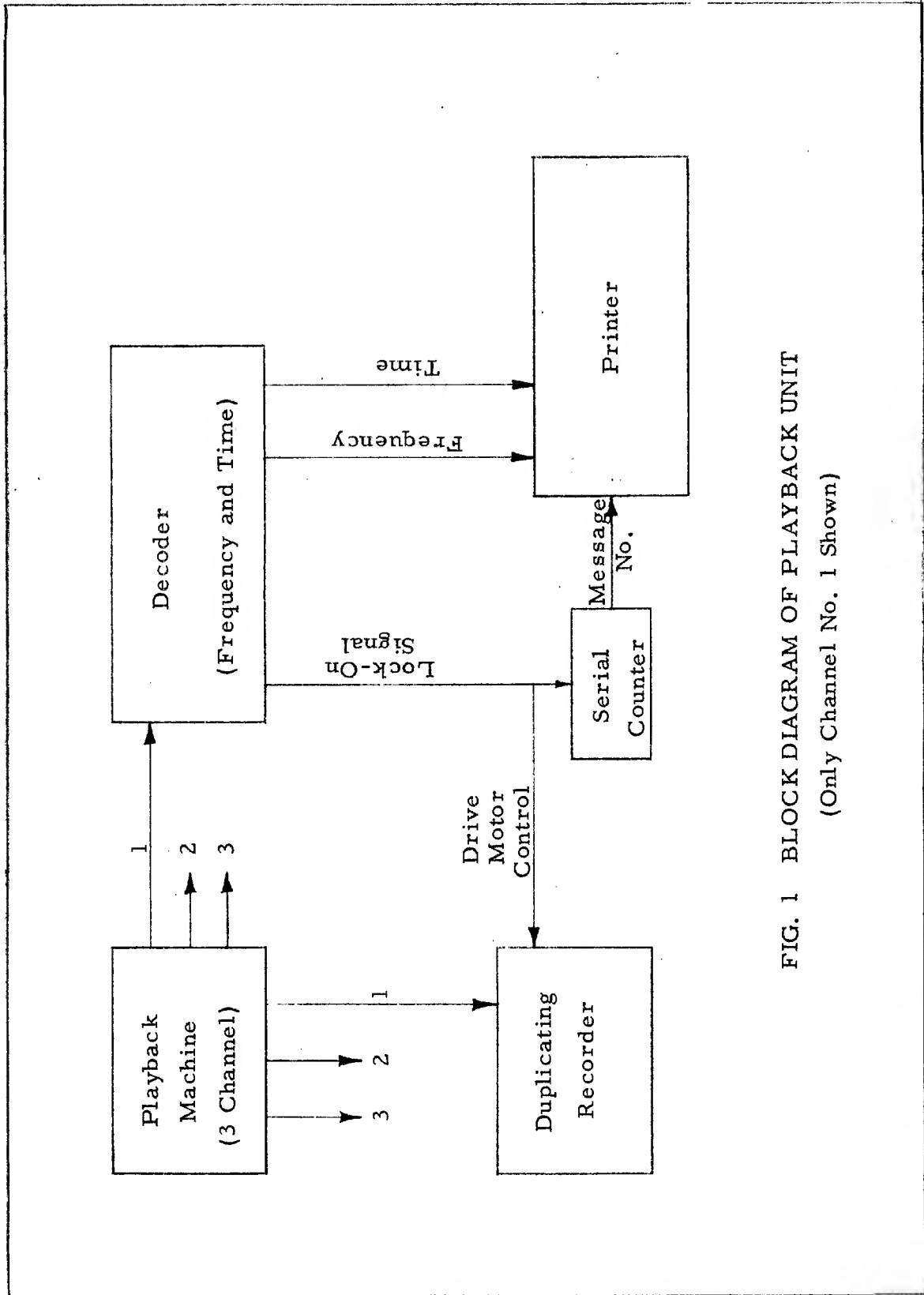


FIG. 1 BLOCK DIAGRAM OF PLAYBACK UNIT
(Only Channel No. 1 Shown)

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